

WHAT IS CLAIMED IS:

- 1 1. A method for forming a silicon oxide layer over a substrate
2 disposed in a high density plasma substrate processing chamber, said method
3 comprising:
4 flowing a process gas into the substrate processing chamber, said
5 process gas comprising a silicon-containing source, an oxygen-containing source and a
6 fluorine-containing source;
7 forming a plasma from said process gas; and
8 heating the substrate to a temperature above 450°C during deposition of
9 said silicon oxide layer.
- 1 2. The method of claim 1 wherein the substrate is heated to a
2 temperature above 500°C during deposition of said silicon oxide layer.
- 1 3. The method of claim 1 wherein the substrate is maintained at a
2 temperature between 500-600°C during deposition of said silicon oxide layer.
- 1 4. The method of claim 1 wherein said silicon-containing gas is
2 SiH₄.
- 1 5. The method of claim 1 wherein said oxygen-containing source is
2 O₂.
- 1 6. The method of claim 1 wherein said silicon oxide layer has a
2 fluorine content of less than 1.0 at. %.
- 1 7. The method of claim 6 wherein said fluorine-containing source is
2 either NF₃ or a fluorocarbon having a formula of C_nF_{2n+2} where n is a positive integer.
- 1 8. The method of claim 7 wherein the plasma has an ion density of
2 at least 1×10^{11} ions/cm³.
- 1 9. The method of claim 1 wherein a flow ratio of said
2 oxygen-containing source to said silicon-containing source is between 1.4-3.0:1
3 inclusive.

1 10. A method for forming a silicon oxide layer over a substrate
2 disposed in a high density plasma substrate processing chamber, said method
3 comprising:
4 (a) flowing a first gas into the substrate processing chamber;
5 (b) forming a plasma having an ion density of at least 1×10^{11}
6 ions/cm³ from said first gas and allowing said plasma to heat said substrate;
7 (c) thereafter, flowing a process gas comprising a silicon-containing
8 source, an oxygen-containing source and a fluorine-containing source into said
9 substrate processing chamber; and
10 (d) forming a plasma having an ion density of at least 1×10^{11}
11 ions/cm³ from said process gas and allowing said plasma to heat said substrate to a
12 temperature at or above 450°C during deposition of said silicon oxide layer.

1 11. The method of claim 10 wherein said oxygen-containing source
2 is O₂ and said silicon-containing source is SiH₄.

1 12. The method of claim 11 wherein said first gas comprises one or
2 more of argon and O₂.

1 13. The method of claim 10 wherein said fluorine-containing source
2 is either NF₃ or a gas having the formula of C_nF_{2n+2} where n is a positive integer.

1 14. The method of claim 13 wherein a flow ratio of said
2 oxygen-containing source to said silicon-containing source is between 1.4-3.0:1
3 inclusive.

1 15. The method of claim 10 wherein said silicon oxide layer has a
2 fluorine content of less than 1.0 at. %.

1 16. The method of claim 10 wherein in (d) said plasma heats said
2 substrate to a temperature of 500°C or more.

1 17. A method for forming a silicon oxide layer over a substrate
2 disposed in a high density plasma substrate processing chamber, said method
3 comprising:

4 (a) flowing a first gas comprising at least one of an inert gas and O₂
5 into the substrate processing chamber;

6 (b) forming a plasma having an ion density of at least 1×10^{11}
7 ions/cm³ from said first gas and allowing said plasma to heat said substrate;

8 (c) thereafter, depositing said silicon oxide layer by flowing a
9 process gas comprising SiH₄, O₂ and a fluorine-containing source into said substrate
10 processing chamber while maintaining said plasma and allowing said plasma to heat
11 said substrate to a temperature above 450°C during deposition of said silicon oxide
12 layer;

13 wherein said silicon oxide layer has a fluorine concentration of 1.0 at. %
14 or less.

1 18. The method of claim 17 wherein said silicon oxide layer has a
2 fluorine content of 0.6 at. % or less.

1 19. The method of claim 18 wherein a flow rate of said
2 fluorine-containing source is greater than or equal to a flow rate of SiH₄.

1 20. The method of claim 17 wherein said fluorine-containing source
2 is NF₃.

1 21. The method of claim 17 wherein said fluorine-containing source
2 is a fluorocarbon having a formula of C_nF_{2n+2} where n is a positive integer.

1 22. The method of claim 17 wherein a flow ratio of said
2 oxygen-containing source to said silicon-containing source is between 1.6-2.5:1
3 inclusive.

1 23. The method of claim 20 wherein a flow rate of NF₃ is between
2 50-150 sccm and a flow rate of SiH₄ is between 50-150 sccm.

1 24. The method of claim 23 wherein a flow rate of NF₃ is greater
2 than or equal to a flow rate of SiH₄.